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H4P PDCSL
U1S S2213

(56) Documents Cited
EP 0773638 A1 WO 96/00991 A1 JP 040185130 A
US 5248982 A US 4189733 A

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INT CL[6] H04B 1/707 7/08 7/216 7/26, H04J 13/00 13/02 13/04 13/06, H04L 27/227 27/38
Online: WPI, EPODOC, JAPIO

(54) Abstract Title

CDMA receiver where the received signals are phase adjusted/time delayed and then summed before despreading

(57) A code division multiple access (CDMA) receiver for analog signals has a plurality of antennas each receiving a signal [Fig. 2] or at least one antenna receiving a plurality of time delayed signals [shown] to provide space and time diversity respectively. These signals are AD converted 202 and stored 203. The phase of the signals is then controlled by the time delay means 205/6 and phase control means 207/208 and the amplitude controlled by the amplify means 209/210. The controlled signals are then added 211 and the summed signal fed to a correlator 212 where it is multiplied by the spreading code to achieve despreading of the signal.

The system uses one correlator per output channel rather than one per receiving finger which allows reduction in apparatus size. The system is applicable to RAKE receivers and may have multiple correlators with different chipping sequences fed from the addition section to allow reception of multiple channels [Fig. 4] or may have multiple time delayed signals received at a plurality of antennas [Fig. 5].

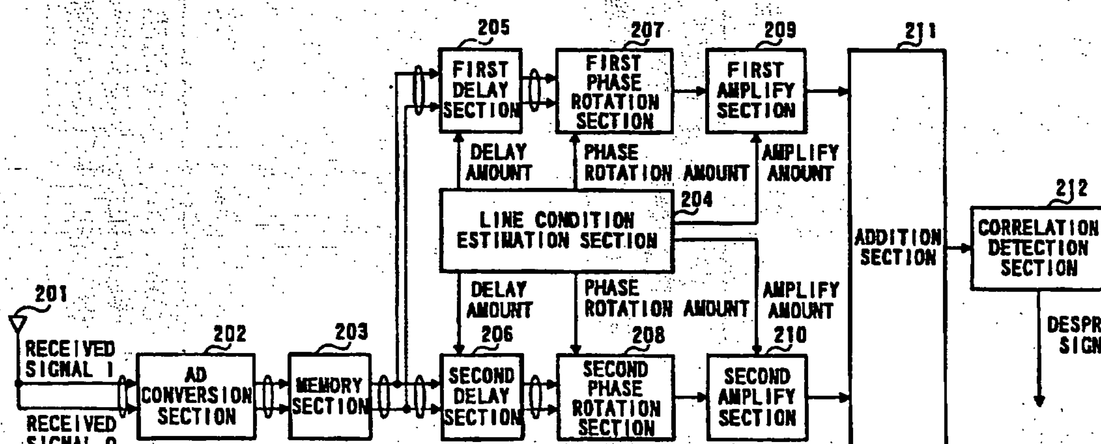

FIG. 3

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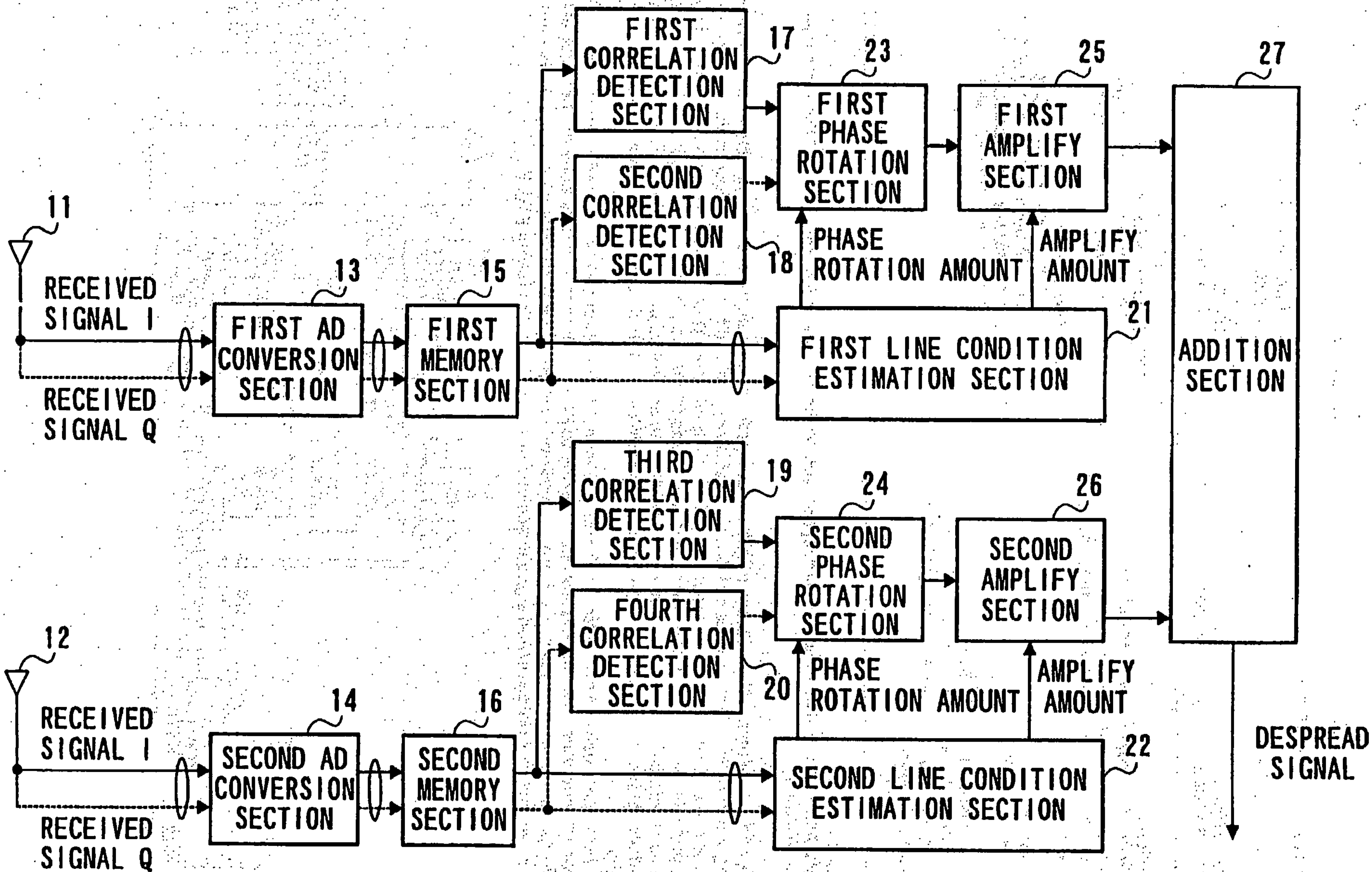


PRIOR ART

FIG. 1

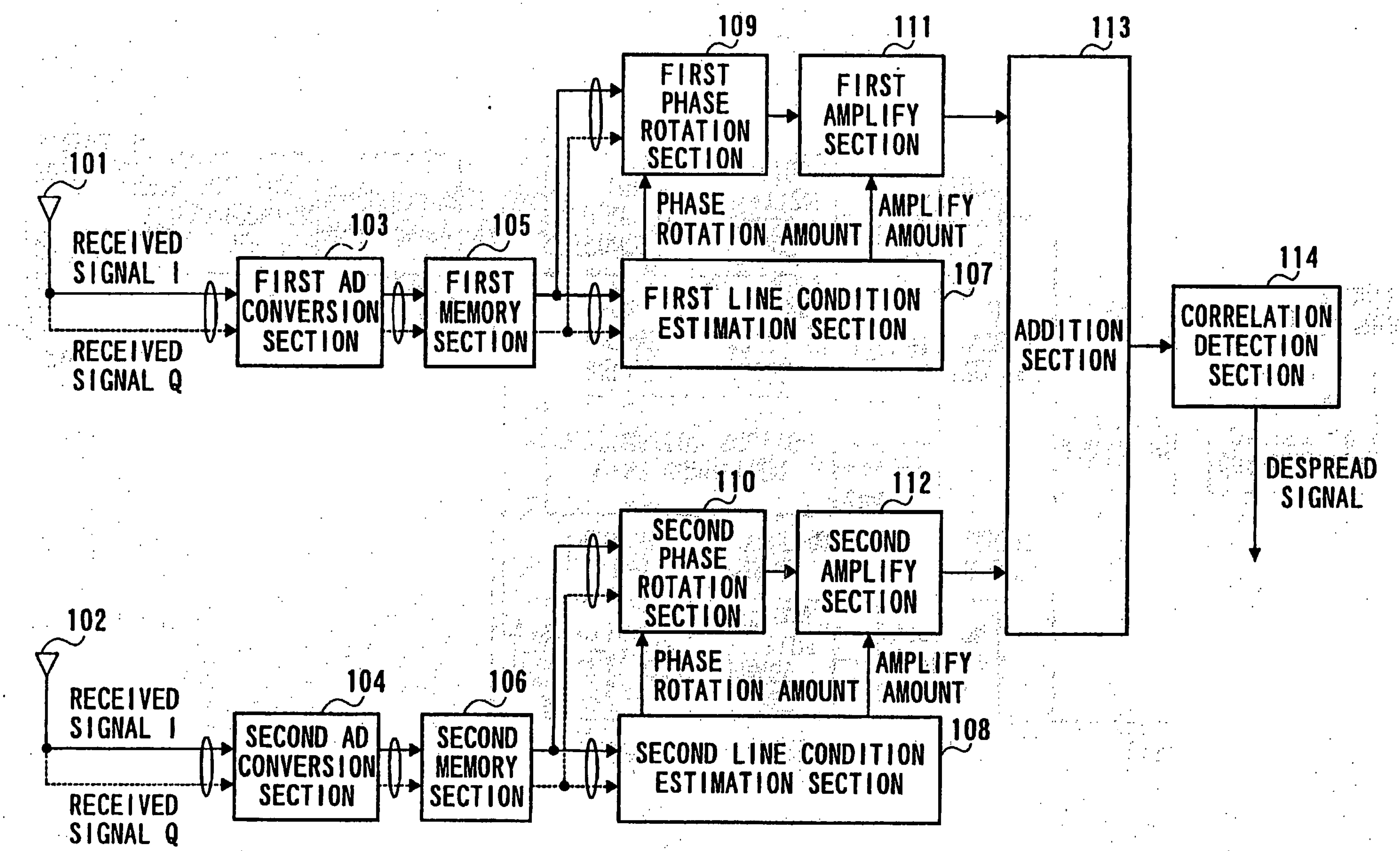
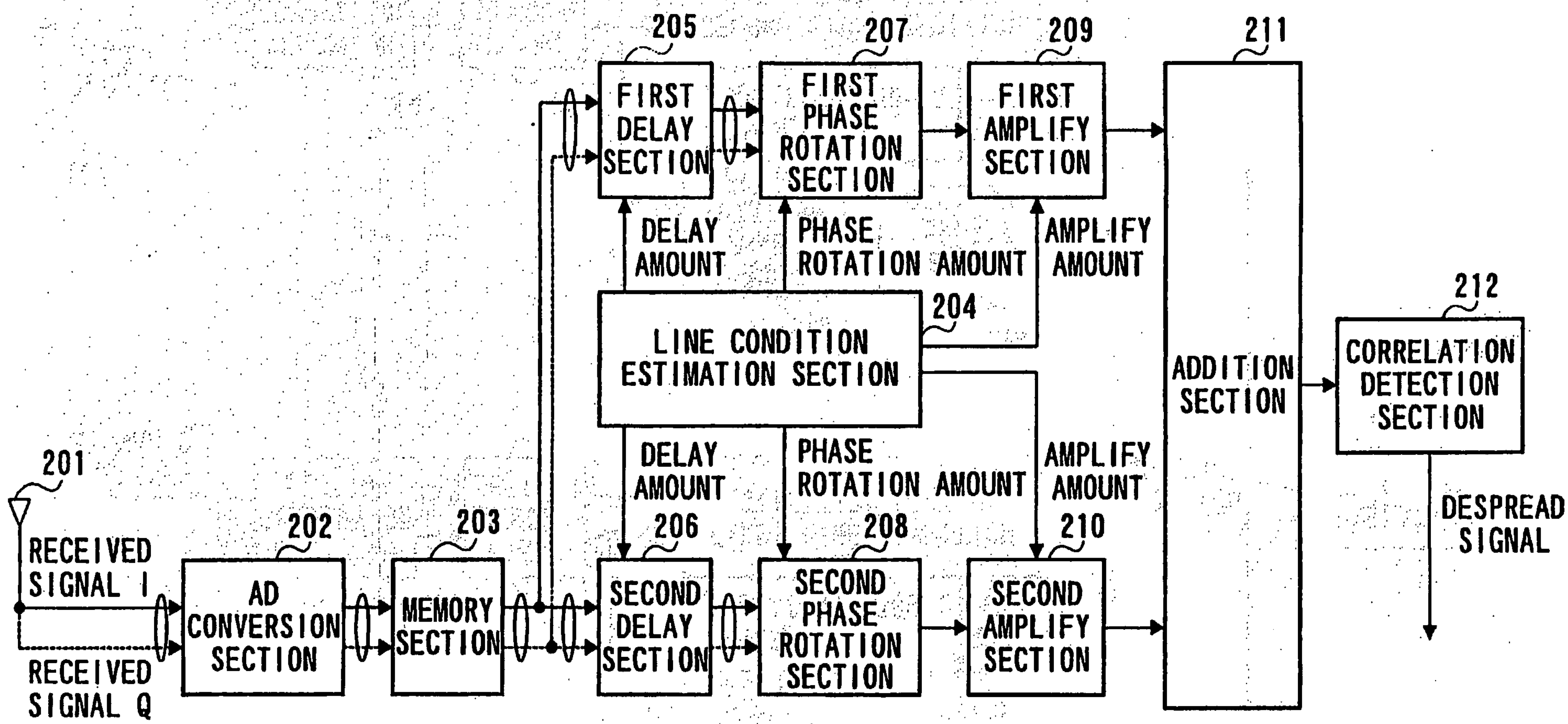
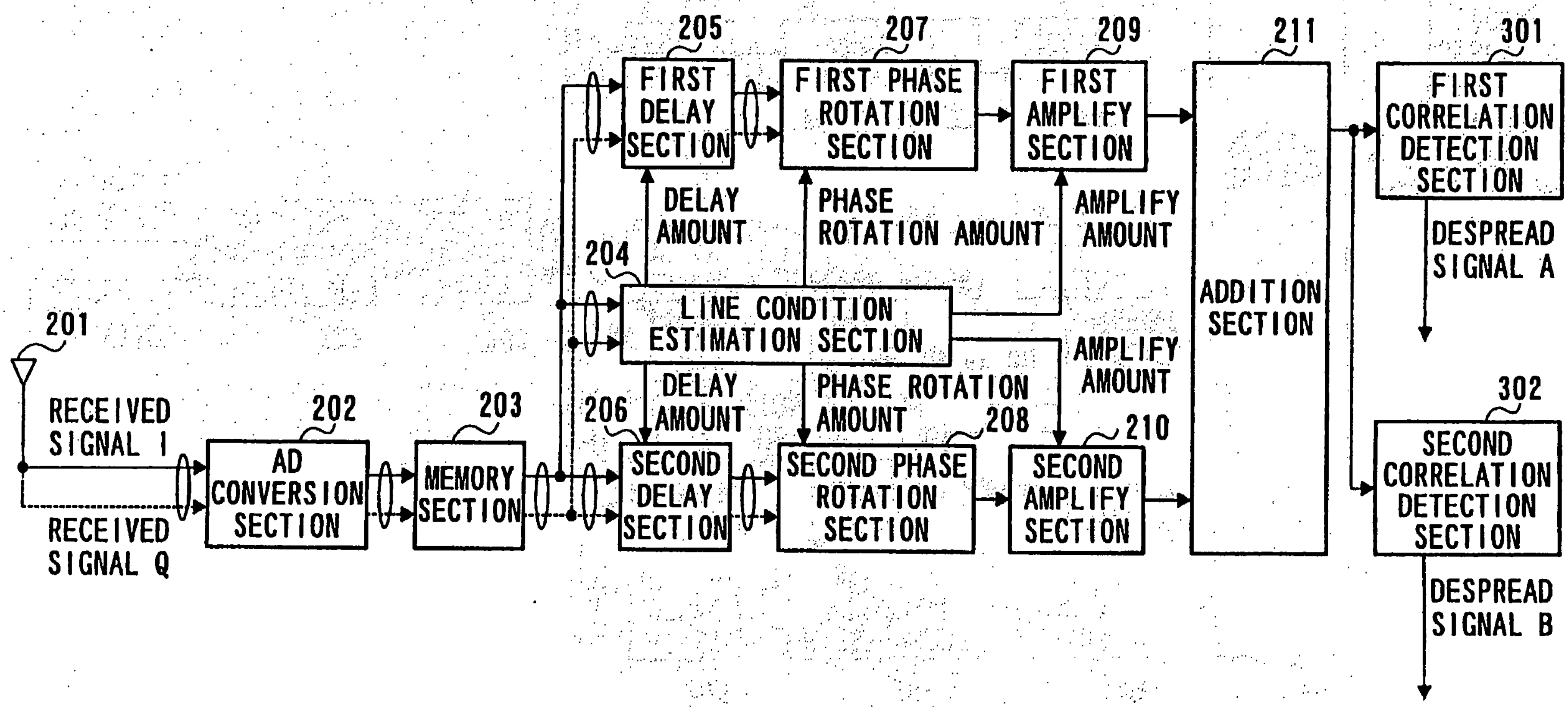

101
102
RECEIVED SIGNAL I
RECEIVED SIGNAL Q
RECEIVED SIGNAL I
RECEIVED SIGNAL Q
103
FIRST AD CONVERSION SECTION
104
SECOND AD CONVERSION SECTION
105
FIRST MEMORY SECTION
106
SECOND MEMORY SECTION
107
FIRST LINE CONDITION ESTIMATION SECTION
108
SECOND LINE CONDITION ESTIMATION SECTION
109
FIRST PHASE ROTATION SECTION
110
SECOND PHASE ROTATION SECTION
111
FIRST AMPLIFY SECTION
112
SECOND AMPLIFY SECTION
PHASE ROTATION AMOUNT
AMPLIFY AMOUNT
PHASE ROTATION AMOUNT
AMPLIFY AMOUNT
113
ADDITION SECTION
114
CORRELATION DETECTION SECTION
DESPREAD SIGNAL

FIG. 2



201
RECEIVED SIGNAL I
RECEIVED SIGNAL Q
202
AD CONVERSION SECTION
203
MEMORY SECTION
205
FIRST DELAY SECTION
207
FIRST PHASE ROTATION SECTION
209
FIRST AMPLIFY SECTION
DELAY AMOUNT
PHASE ROTATION AMOUNT
AMPLIFY AMOUNT
204
LINE CONDITION ESTIMATION SECTION
DELAY AMOUNT
PHASE ROTATION AMOUNT
AMPLIFY AMOUNT
206
SECOND DELAY SECTION
208
SECOND PHASE ROTATION SECTION
210
SECOND AMPLIFY SECTION
211
ADDITION SECTION
212
CORRELATION DETECTION SECTION
DESPREAD SIGNAL

FIG. 3


201
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RECEIVED SIGNAL Q
202
AD CONVERSION SECTION
203
MEMORY SECTION
204
LINE CONDITION ESTIMATION SECTION
205
FIRST DELAY SECTION
206
SECOND DELAY SECTION
DELAY AMOUNT
DELAY AMOUNT
207
FIRST PHASE ROTATION SECTION
208
SECOND PHASE ROTATION SECTION
PHASE ROTATION AMOUNT
PHASE ROTATION AMOUNT
209
FIRST AMPLIFY SECTION
210
SECOND AMPLIFY SECTION
AMPLIFY AMOUNT
AMPLIFY AMOUNT
211
ADDITION SECTION
301
FIRST CORRELATION DETECTION SECTION
302
SECOND CORRELATION DETECTION SECTION
DESPREAD SIGNAL A
DESPREAD SIGNAL B

FIG. 4

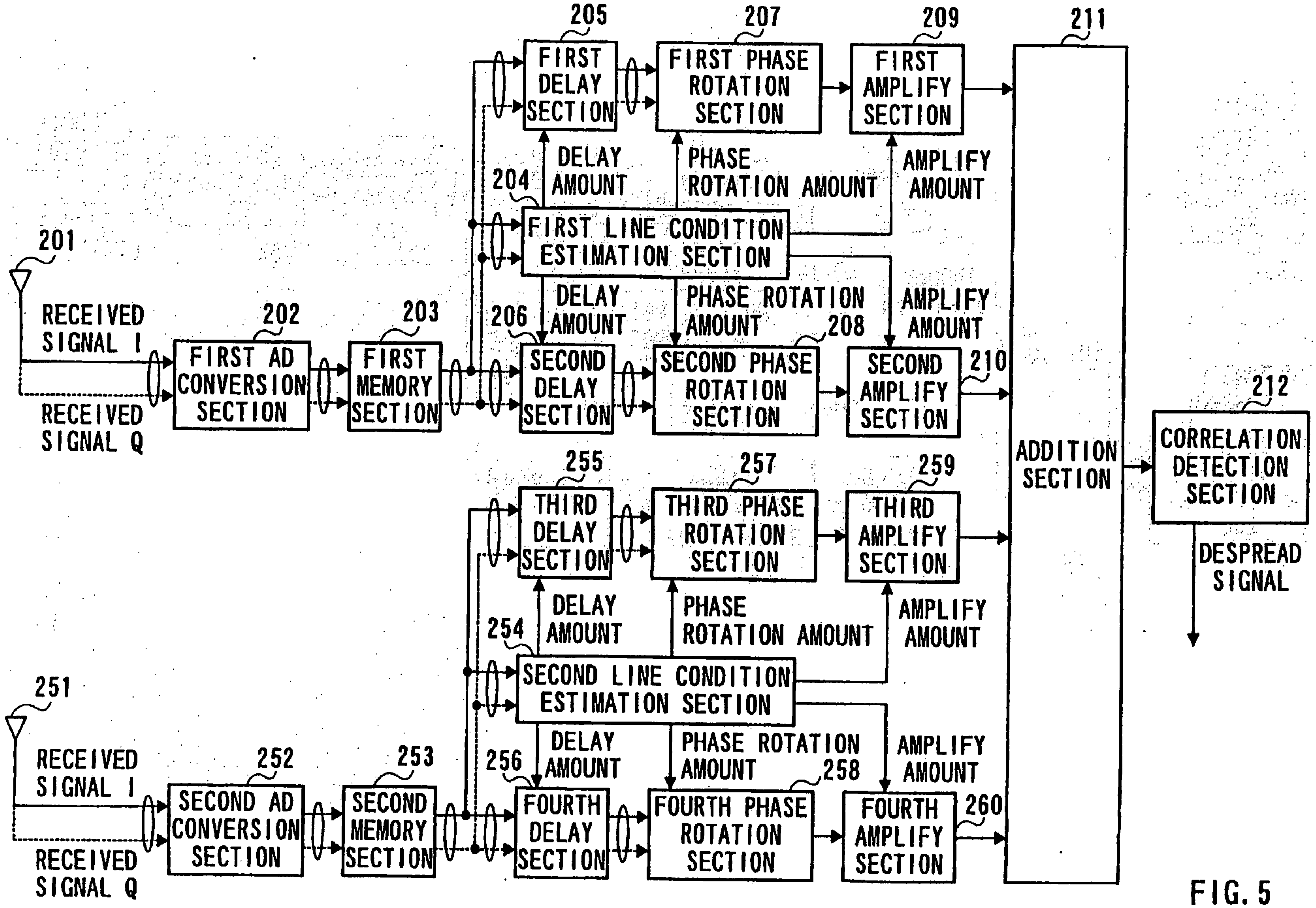
201
RECEIVED SIGNAL I
RECEIVED SIGNAL Q
202
FIRST AD CONVERSION SECTION
203
FIRST MEMORY SECTION
204
FIRST LINE CONDITION ESTIMATION SECTION
205
FIRST DELAY SECTION
206
SECOND DELAY SECTION
207
FIRST PHASE ROTATION SECTION
208
SECOND PHASE ROTATION SECTION
209
FIRST AMPLIFY SECTION
210
SECOND AMPLIFY SECTION
DELAY AMOUNT
PHASE ROTATION AMOUNT
AMPLIFY AMOUNT
211
ADDITION SECTION
212
CORRELATION DETECTION SECTION
DESPREAD SIGNAL
251
RECEIVED SIGNAL I
RECEIVED SIGNAL Q
252
SECOND AD CONVERSION SECTION
253
SECOND MEMORY SECTION
254
SECOND LINE CONDITION ESTIMATION SECTION
255
THIRD DELAY SECTION
256
FOURTH DELAY SECTION
257
THIRD PHASE ROTATION SECTION
258
FOURTH PHASE ROTATION SECTION
259
THIRD AMPLIFY SECTION
260
FOURTH AMPLIFY SECTION

FIG. 5

CDMA RECEIVING APPARATUS AND CDMA COMMUNICATION METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a CDMA receiving apparatus and a CDMA communication method which perform RAKE combining of received signals to detect the correlation while performs radio communications using a CDMA system.

Recently, in a cellular system such as a car telephone and a portable telephone, techniques to improve spectral efficiency have become important in order to ensure more user capacity over the limited frequency band.

As a multiple access system to use spectra efficiently, a code division multiple access (CDMA) system has been paid attention. The CDMA system is able to achieve excellent communication qualities by spread band characteristics and acute correlation characteristics using spreading codes.

One of CDMA systems is a direct sequence system in which a transmission signal is multiplied by a spreading code. When the direct sequence system is used, it is possible to obtain a diversity effect by performing RAKE receiving of multipath components to perform maximal-ratio combining.

Receiving processing in a conventional CDMA receiving apparatus will be described below using a block diagram in FIG.1. In addition, FIG.1 illustrates the case where the antenna branch number is two, the finger number for RAKE combining is one for a branch, and a QPSK modulation is performed.

An in-phase component and a quadrature component of an analog signal received at first antenna 11 are converted into respective digital signals at first AD conversion section 13 and stored at first memory section 15.

Then, the digital signal output from first memory section 15 is processed at first line condition estimation section 21 to estimate a phase rotation amount and received level based on a multiplexed pilot signal.

The in-phase component of the digital signal output from

first memory section 15 is despread processed at first correlation detection section 17, and the correlation value of bit rate is output to phase rotation section 23. In the same way, the quadrature component of the digital signal output from first memory section 15 is despread processed at second correlation detection section 18, and the correlation value of bit rate is output to first phase rotation section 23.

The correlation values of the in-phase component and quadrature component are controlled on a bit-by-bit basis in order to obtain equal rotation amounts, equal scales and reverse rotation angles with respect to the received signal phases. Then, amplitudes are amplified at first amplify section 25 based on the amplify amount output from first line condition estimation section 21 to be output to addition section 27.

An analog signal received at second antenna 12 is processed in the same way as the analog signal received at first antenna 11 then output to addition section 27. It is possible to perform maximal-ratio combining of received signal by adding each signal input to addition section 27.

By compensating phases of signals received at different antennas via separate propagation paths to perform maximal-ratio combining, it is possible to largely reduce a fluctuation amount of a signal due to fading as compared with a signal not subjected to the combining, thereby enabling communication qualities to be improved.

However, since the above-described conventional receiving apparatus should comprise a large number of correlators for diversity receiving with a plurality of antennas under multipath condition, a circuit size of the apparatus becomes large, which remains the problem that it is not possible to perform downsizing and lightening of an apparatus.

It is an object of the present invention is to provide a CDMA receiving apparatus and a CDMA communication method in

which the number of correlators is decreased in order to enable downsizing and lightening of the apparatus.

The present invention achieves the above object by controlling a phase rotation amount of a signal received at each antenna to amplify an amplitude of the received signal, adding each signal, and then performing correlation detection to obtain despread signals.

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawing wherein one example is illustrated by way of example, in which;

FIG.1 is a block diagram illustrating a configuration of a conventional CDMA receiving apparatus;

FIG.2 is a block diagram illustrating a configuration of a CDMA receiving apparatus according to a first embodiment;

FIG.3 is a block diagram illustrating a configuration of a CDMA receiving apparatus according to a second embodiment;

FIG.4 is a block diagram illustrating a configuration of a CDMA receiving apparatus according to the second embodiment at the time of two-code multiplexed transmission; and

FIG.5 is a block diagram illustrating a configuration of a CDMA receiving apparatus according to a combination of the first embodiment and second embodiment.

Some embodiments of the present invention will be described in detail below using accompanying drawings.

(First embodiment)

The first embodiment will describe the case of detecting the correlation of signals which are transmitted via separate propagation paths and received at different antennas at the same time.

The configuration of a CDMA receiving apparatus according to the first embodiment will be described using a block diagram in FIG.2. In addition, FIG.2 illustrates the case where the number of antenna branches is two, the finger number for RAKE combining is one for a branch, and a QPSK modulation is performed.

In the CDMA receiving apparatus illustrated in FIG.2, first antenna 101 and second antenna 102 receive signals transmitted from a communication partner via separate propagation paths at the same timing. First AD conversion section 103 and second AD conversion section 104 convert respectively analog signals received at first antenna 101 and second antenna 102 into digital signals. First memory section 105 and second memory section 106 are to respectively store the digital signals converted at first AD conversion section 103 and second AD conversion section 104 temporarily.

First line condition estimation section 107 and second line condition estimation section 108 respectively estimate line conditions of the signals output from first memory section 105 and second memory section 106. First phase rotation section 109 and second phase rotation section 110 respectively control phases of the signals output from first memory section 105 and second memory section 106 on a chip-by-chip basis corresponding to the line conditions. First amplify section 111 and second amplify section 112 amplify amplitudes of the signals output from first phase rotation section 109 and second phase rotation section 110 corresponding to the line conditions.

Addition section 113 adds the signals output from first amplify section 111 and second amplify section 112. Correlation detection section 114 processes despreading by multiplying the signal output from addition section 113 by a spreading code to detect the correlation and output the despread signal.

Receiving processing in the CDMA receiving apparatus according the first embodiment will be described next.

First, an in-phase component and a quadrature component

of an analog signal received at first antenna 101 are converted into respective digital signals at first AD conversion section 103 and stored at first memory section 105.

Then, the digital signal output from first memory section 105 is processed at first line condition estimation section 107 to estimate a phase rotation amount and received level based on a multiplexed pilot signal.

Further, the digital signal output from first memory section 105 is controlled at first phase rotation section 109 on a chip-by-chip basis so that the phases of the received signal have equal rotation amounts, equal scales, and reverse rotation angles, processed at first amplify section 111 to amplify the amplitude, and output to addition section 113.

An analog signal received at second antenna 102 is processed in the same way as the analog signal received at first antenna 101 then output to addition section 113.

Each signal input to addition section 113 is added, then subjected to despreading processing at correlation detection section 114, and the despread signal is output.

An output signal from the CDMA receiving apparatus according to the first embodiment will be described next comparing with the conventional CDMA receiving apparatus.

As an example, assume a code in which a single symbol is composed of four chips.

Vectors of in-phase component and quadrature component of a signal received at the first antenna and subjected to AD conversion are referred to as a, b, c and d in the order of the first to fourth chips. Vectors of in-phase component and quadrature component of a signal received at the second antenna and subjected to AD conversion are referred to as h, i, j and k also in the order of the first to fourth chips. Further, coefficients of a correlator are referred to as α, β, γ and δ in the order of the first to fourth chip. Furthermore, a phase rotation amount and amplitude of the received signal at the first antenna are respectively referred to as -p and m, and a phase rotation amount and amplitude of the received signal at the second antenna are respectively referred to as -q and

n.

Correlation value s1 and correlation value s2 respectively of the received signals at the first antenna and the second antenna in the conventional CDMA receiving apparatus are represented with equation (1) indicated below.

$$s1=a\alpha+b\beta+c\gamma+d\delta$$
$$s2=h\alpha+i\beta+j\gamma+k\delta \qquad (1)$$

At this point, since it is necessary to obtain each of correlation values of an in-phase component and quadrature component of the received signal at the first antenna and an in-phase component and quadrature component of the received signal at the second antenna, total four correlation detection sections are needed. In addition, when a rotation amount of angle θ is referred to as $R(\theta)$, RAKE combining value T is represented with equation (2) below.

$$T=(a\alpha+b\beta+c\gamma+d\delta)mR(p)$$
$$+(h\alpha+i\beta+j\gamma+k\delta)nR(q) \qquad (2)$$

At this point, the CDMA receiving apparatus executes transmission power control based on the power level of the despread signal. The value needed for this control is only an in-phase component of RAKE combining value T described above.

At next point, in the CDMA receiving apparatus according to the first embodiment, the received signal at the first antenna becomes amR(p), bmR(p), cmR(p) and dmR(p) in the order of the first to fourth chips, and the received signal at the second antenna becomes hnR(q), inR(q), jnR(q) and knR(q) in the order of the first to fourth chips. Therefore, the addition value becomes amR(p)+hnR(q), bmR(p)+inR(q), cmR(p)+jnR(q) and dmR(p)+knR(Q) in the order of the first to fourth chips. Accordingly, correlation value s is represented with equation (3) indicated below.

$$s=(amR(p)+hnR(q))\alpha+(bmR(p)+inR(q))\beta$$
$$+(cmR(p)+jnR(q))\gamma+(dmR(p)+knR(q))\delta$$
$$s=(a\alpha+b\beta+c\gamma+d\delta)mR(p)$$
$$+(h\alpha+i\beta+j\gamma+k\delta)nR(q) \qquad (3)$$

As been apparent from equations (2) and (3), correlation

value s in the CDMA receiving apparatus according to the first embodiment matches RAKE combining value T.

As described above, since the correlation detection is performed with respect to signals received at different antennas after rotating phases and amplifying amplitudes to add, it is possible to make the number of correlation detection sections, a plurality of which are conventionally necessary for RAKE combining, one, thereby enabling downsizing and lightening of the apparatus with excellent communication qualities held.

(Second embodiment)

The second embodiment will describe the case of performing correlation detection of signals which are transmitted via separate propagation paths and received at the same antenna at different timings.

The configuration of a CDMA receiving apparatus according to the second embodiment will be described using a block diagram in FIG.3. In addition, FIG.3 illustrates the case where the number of antenna branches is one, the finger number for RAKE combining is two for a branch, and a QPSK modulation is performed.

In the CDMA receiving apparatus illustrated in FIG.3, first antenna 201 receives signals transmitted from a communication partner via separate propagation paths at the different timings. AD conversion section 202 converts analog signals received at antenna 201 into digital signals. Memory section 203 is to store the digital signals converted at AD conversion section 202 temporarily.

Line condition estimation section 204 estimates line conditions of the signals output from memory section 203. First delay section 205 and second delay section 206 correct delay amounts of the signals output from memory section 203 corresponding to the line conditions. First phase rotation section 207 and second phase rotation section 208 respectively control phases of the signals output from first delay section 205 and second delay section 206 on a chip-by-chip basis corresponding to the line conditions. First amplify section

209 and second amplify section 210 respectively amplify amplitudes of the signals output from first phase rotation section 207 and second phase rotation section 208 corresponding to the line conditions.

Addition section 211 adds the signals output from first amplify section 209 and second amplify section 210. Correlation detection section 212 processes despreading by multiplying the signal output from addition section 211 by a spreading code to detect the correlation and output the despread signal.

Receiving processing in the CDMA receiving apparatus according the second embodiment will be described next.

First, an in-phase component and a quadrature component of an analog signal received at antenna 201 are converted into respective digital signals at AD conversion section 202 and stored at memory section 203.

Then, the digital signal output from memory section 203 is processed at line condition estimation section 204 to estimate a phase rotation amount and received level based on a multiplexed pilot signal.

Further, the digital signal output from memory section 203 is processed at first delay section 205 to correct the delay amount, controlled at first phase rotation section 207 on a chip-by-chip basis so that the phases of the received signal have equal rotation amounts, equal scales, and reverse rotation angles, processed at first amplify section 209 to amplify the amplitude, and output to addition section 211. In the same way, the digital signal output from memory section 203 is processed at second delay section 206 to correct the delay amount, controlled at second phase rotation section 208 so that the phases of the received signal have equal rotation amounts, equal scales, and reverse rotation angles, processed at second amplify section 210 to amplify the amplitude, and output to addition section 211.

Each signal input to addition section 211 is added, then subjected to despreading processing at correlation detection section 212, and the despread signal is output.

An output signal from the CDMA receiving apparatus according to the second embodiment will be described next comparing with the conventional CDMA receiving apparatus.

As an example, assume a code in which a single symbol is composed of four chips. The time sequences of vectors composed of in-phase component and quadrature component of a signal received at the antenna and subjected to AD conversion are referred to as a, b, c, d, e and f sequentially. It is assumed that a is the first chip of a symbol at the first finger and c is the first chip of a symbol at the second finger. Further, coefficients of a correlator are referred to as α, β, γ and δ in the order of the first to fourth chip. Furthermore, a phase rotation amount and amplitude of a received signal at the first finger are respectively referred to as -p and m, and a phase rotation amount and amplitude of a received signal at the second finger are respectively referred to as -q and n.

Correlation value s1 of the received signal at the first finger and correlation value s2 of the received signal at the second finger in the conventional CDMA receiving apparatus are represented with equation (4) indicated below.

$$s1=a\alpha+b\beta+c\gamma+d\delta$$
$$s2=c\alpha+d\beta+e\gamma+f\delta \qquad (4)$$

At this point, since it is necessary to obtain each of correlation values of an in-phase component and quadrature component of the received signal at the first finger and an in-phase component and quadrature component of the received signal at the second finger, total four correlation detection sections are needed. In addition, when a rotation amount of angle θ is referred to as $R(\theta)$, RAKE combining value T is represented with equation (5) below.

$$T=(a\alpha+b\beta+c\gamma+d\delta)mR(p)$$
$$+(c\alpha+d\beta+e\gamma+f\delta)nR(q) \qquad (5)$$

At this point, the CDMA receiving apparatus executes transmission power control based on the power level of the despread signal. The value needed for this control is only an in-phase component of RAKE combining value T described

above.

At next point, in the CDMA receiving apparatus according to the second embodiment, the received signal at the first finger becomes amR(p), bmR(p), cmR(p) and dmR(p) in the order of the first to fourth chips, and the received signal at the second antenna becomes cnR(q), dnR(q), enR(q) and fnR(q). Therefore, the addition value becomes amR(p)+cnR(q), bmR(p)+dnR(q), cmR(p)+enR(q) and dmR(p)+fnR(Q) in the order of the first to fourth chips. Accordingly, correlation value s is represented with equation (6) indicated below.

$$
\begin{aligned}
s &= (amR(p)+cnR(q))\alpha+(bmR(p)+dnR(q))\beta \\
&\quad +(cmR(p)+enR(q))\gamma+(dmR(p)+fnR(Q))\delta \\
s &= (a\alpha+b\beta+c\gamma+d\delta)mR(p) \\
&\quad +(c\alpha+d\beta+e\gamma+f\delta)nR(q) \qquad (6)
\end{aligned}
$$

As been apparent from equations (5) and (6), correlation value s in the CDMA receiving apparatus according to the second embodiment matches RAKE combining value T.

As described above, since the correlation detection is performed with respect to signals received at an antenna at different timings after correcting delay amounts, rotating phases, and amplifying amplitudes to add, it is possible to make the number of correlation detection sections, a plurality of which are conventionally necessary for RAKE combining, one, thereby enabling downsizing and lightening of the apparatus with excellent communication qualities held.

In addition, in the case of transmitting a plurality of signals while multiplexing, it is possible to process by comprising the number of correlation detection sections matching the number of signals. FIG.4 is a block diagram illustrating a configuration of the CDMA receiving apparatus according to the second embodiment at the time of two-code multiplexed transmission.

In the CDMA receiving apparatus illustrated in FIG.4, first correlation detection section 301 and second correlation detection section 302 detect the correlation of different signals by multiplying different spreading codes that are orthogonalized to each other. In addition, since the other

configuration in FIG.4 is the same as FIG.3, the other sections have the same symbols as FIG.3 and their descriptions are omitted.

In addition, the present invention is not limited to the above-described embodiments, and various variations and modifications may be possible without departing from the scope of the present invention. For example, it may be possible to compose a CDMA receiving apparatus by combining the first embodiment and the second embodiment.

FIG.5 illustrates the case where the antenna branch number is two, the finger number for RAKE combining is two for a branch and a QPSK modulation is performed, which is a configuration of a CDMA receiving apparatus by combination of the first embodiment and the second embodiment.

As described above, according to the present invention, since with respect to allotted received signals, delay control, phase rotation control and amplitude control are performed prior to combine, then correlation detection is performed, it is possible to provide a CDMA receiving apparatus and a CDMA communication method for enabling a small number of correlators to perform RAKE combining and thereby achieving downsizing and lightening of the apparatus.

The present invention is not limited to the above described embodiments, and various variations and modifications may be possible without departing from the scope of the present invention.

This application is based on the Japanese Patent Application No.HEI10-139989 filed on May 21 1998, entire content of which is expressly incorporated by reference herein.

CLAIMS

1. A CDMA receiving apparatus comprising:

a plurality of phase rotation means for controlling each phase rotation of spread signals received at different antennas;

addition means for adding said spread signals of which phases are controlled; and

correlation detection means for performing correlation detection by multiplying the added spread signal by a spreading code to detect correlation.

2. A CDMA receiving apparatus comprising:

a plurality of delay means for correcting each delay of spread signals received at an antenna at a different plurality of timings;

a plurality of phase rotation means for controlling each phase rotation of spread signals output from respective delay means;

addition means for adding said spread signals of which phases are controlled; and

correlation detection means for performing correlation detection by multiplying the added spread signal by a spreading code to detect correlation.

3. A CDMA receiving apparatus according to claim 2 further comprising a plurality of antennas, wherein each antenna receives a spread signal at a different plurality of timings.

4. The CDMA receiving apparatus according to claim 1, wherein the phase rotation means controls the phase rotation of a spread signal on a chip-by-chip basis.

5. A base station apparatus comprising CDMA receiving apparatus, wherein said CDMA receiving apparatus comprises a plurality of phase rotation means for controlling each phase rotation of spread signals received at different antennas, addition means for adding said spread signals of which phases are controlled and correlation detection means for performing correlation detection by multiplying the added spread signal by a spreading code to detect correlation.

6. A terminal station apparatus comprising CDMA receiving apparatus, wherein said CDMA receiving apparatus comprises a plurality of phase rotation means for controlling each phase rotation of spread signals received at different antennas, addition means for adding said spread signals of which phases are controlled and correlation detection means for performing correlation detection by multiplying the added spread signal by a spreading code to detect correlation.

7. A CDMA communication method in which each phase rotation of spread signals received at different antennas is controlled before the spread signals are added, and the added spread signal is multiplied by a spreading code to detect correlation.

8. A CDMA communication method in which with respect to spread signals received at an antenna at a different plurality of timings, each delay is corrected and each phase rotation is controlled before the spread signals are added, and the added spread signal is multiplied by a spreading code to detect correlation.

9. The CDMA communication method according to claim 8, wherein a plurality of antennas are comprised and spread signals are received at each of the antennas at a different plurality of timings.

10. A CDMA receiving apparatus constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

11. A CDMA communication method substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB 9911575.0
Claims searched: 1,4-7,10,11
Examiner: Owen Wheeler
Date of search: 2 December 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4P (PDCSL)

Int Cl (Ed.6): H04B: 1/707, 7/08, 7/216, 7/26; H04J: 13/00, 13/02, 13/04, 13/06; H04L: 27/227, 27/38.

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0773638 A1	[AT&T] See in particular Figs. 2,3A and 6.	1,7
X	WO 96/00991 A1	[INTERDIGITAL] See in particular Figs. 1,3,4 and page 5 line 11 to page 7 line 20 and page 13 line 21 to page 15 line 18.	1,5-7
X	JP 040185130 A	[CLARION] See abstract.	1,7
X	US 5248982 A	[REINHARDT] See in particular Figs. 1 and 5, column 3 lines 28-60 and column 4 line 54 to column 5 line 27.	1,7
X	US 4189733 A	[MALM] See Fig. 2 and column 3 line 61 to column 4 line 33.	1,7

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.